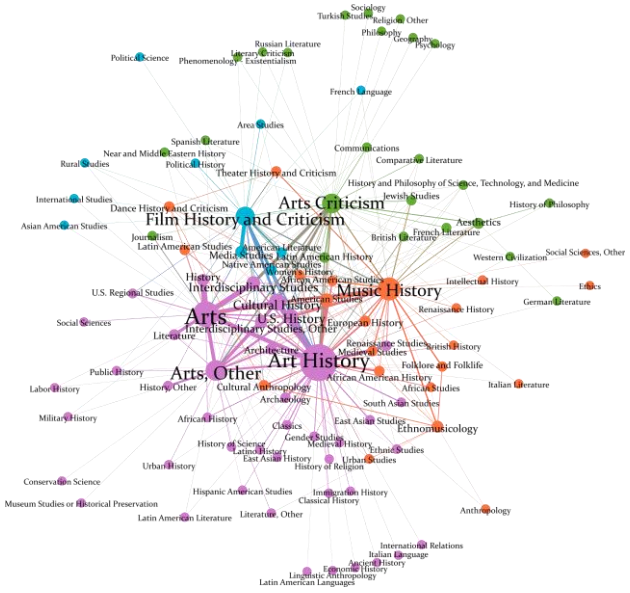
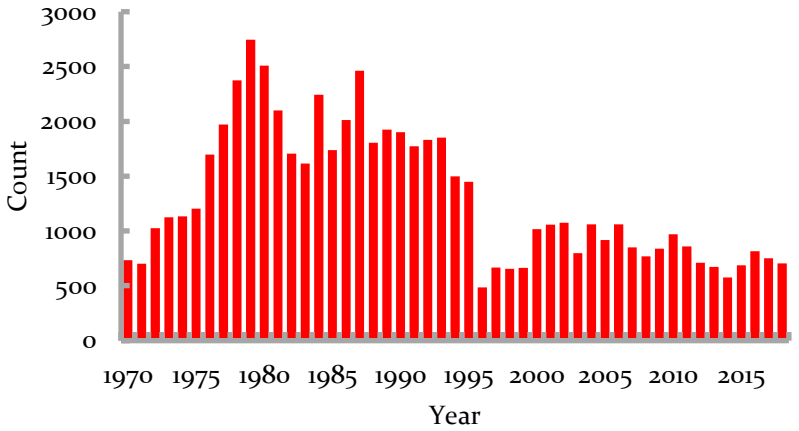
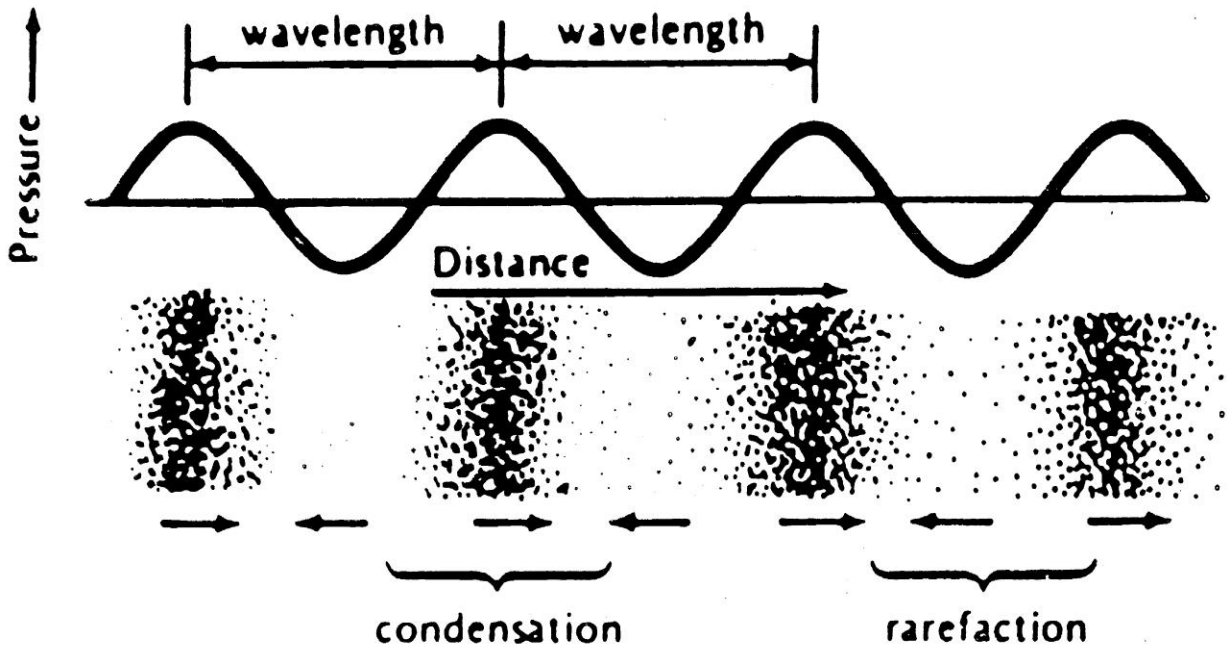
VPA 5300: The Digital Humanities in the Arts



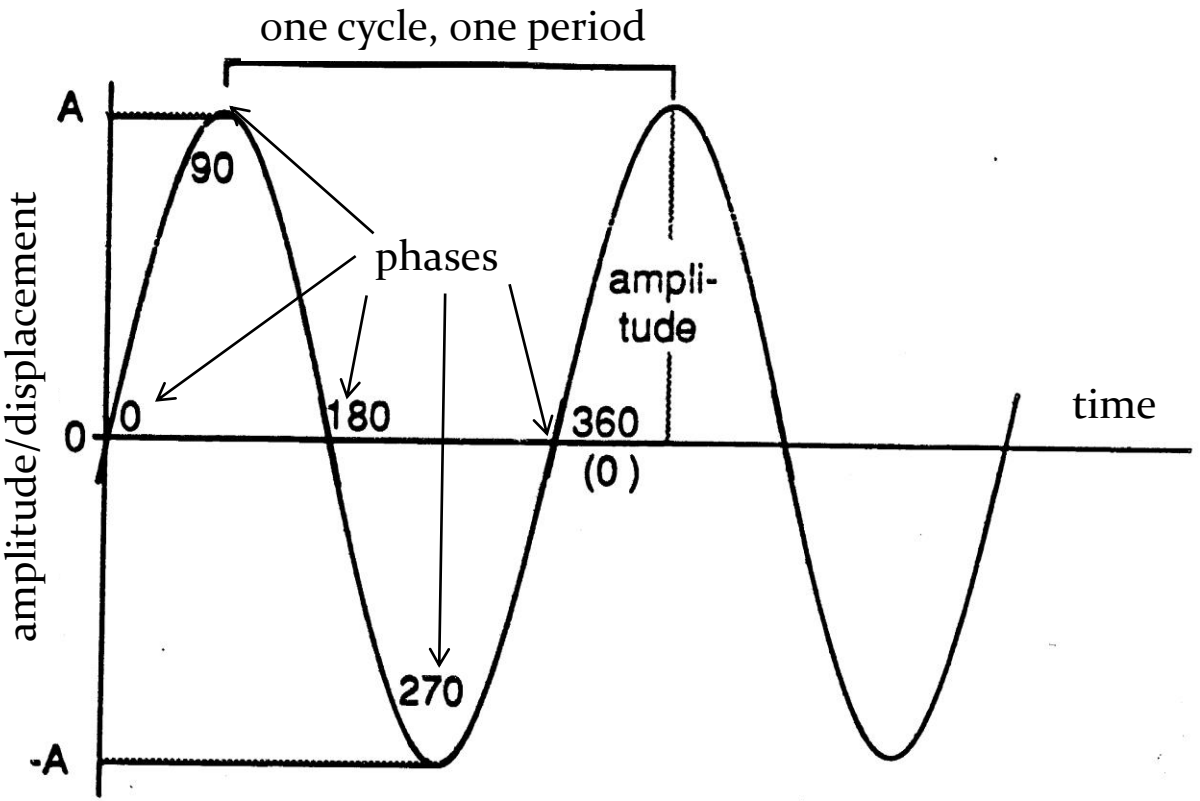
Week 7 – 01
Sound



Sound waves


wavelength
wavelength
Pressure
Distance
condensation
rarefaction

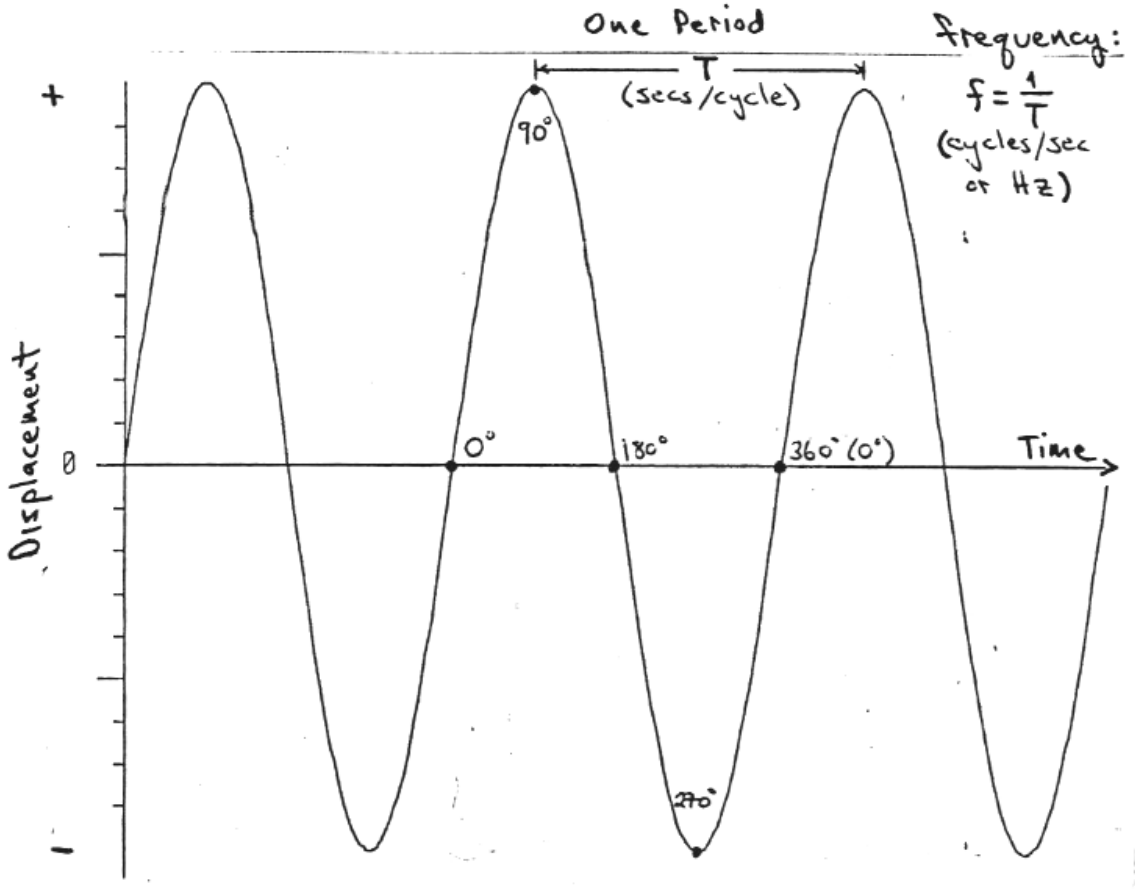
Sinusoidal wave



Sinusoidal wave

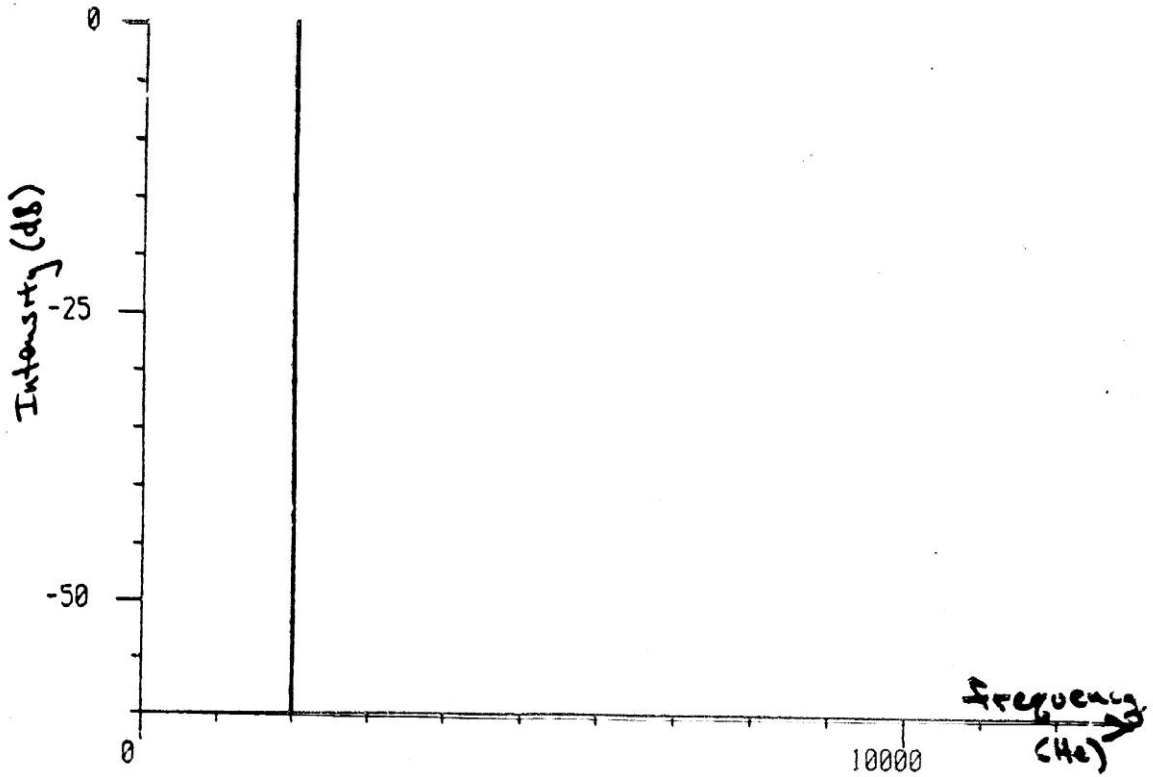
Heinrich Hertz (1857-1894) proved that electricity can be transmitted in electromagnetic waves, leading to the radio.

Frequency = 1/Period



Frequency spectrum

Joseph Fourier (1768-1830) invented the Fourier series: any complex waveform can be represented as a sum of sinusoidal waveforms.



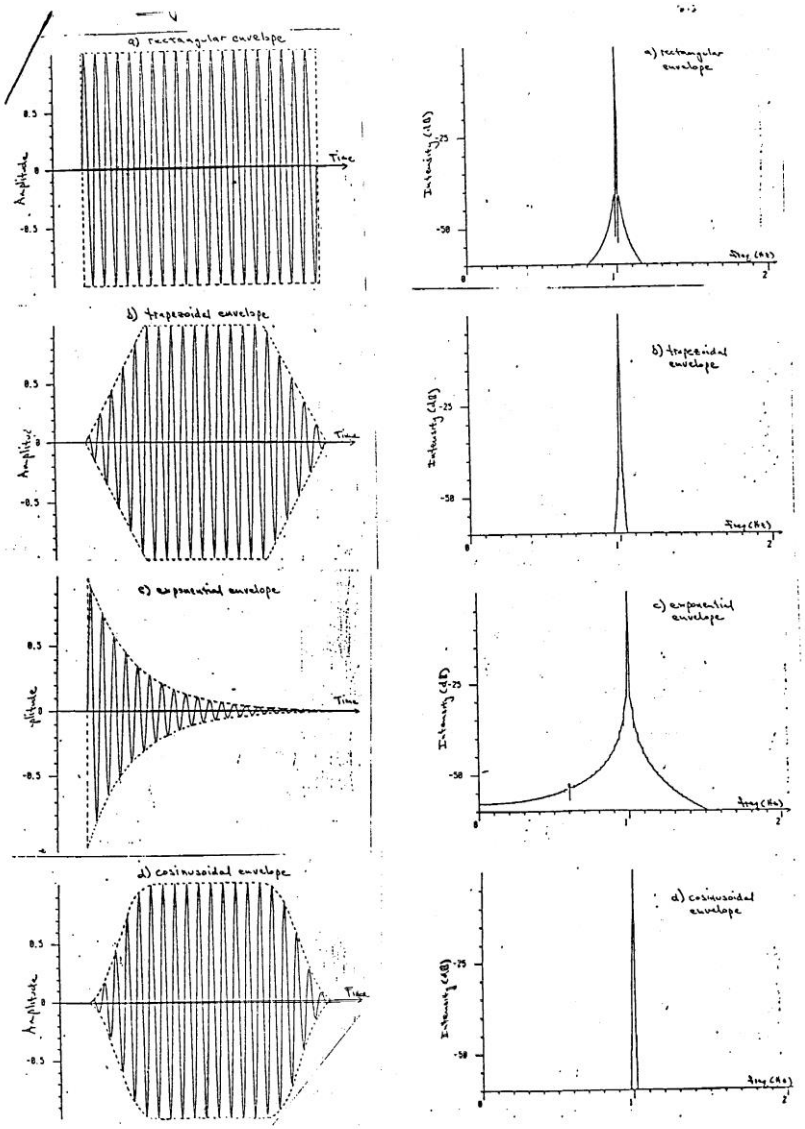
Decibel scale

- Sound pressure is measured in microPascals (μPa).
- What is important for hearing is the *ratio* between levels (i.e., we need a relative scale)
- Sound Pressure Level (SPL) is measured in decibels (dB) and is proportional to the ratio of sound pressures
- $L\ (dB) = 20 \log p/p_0$
  - where p_0 = 20 μPa for SPL, i.e. 0 dB SPL = 20 μPa
- The decibel scale is a logarithmic scale

Decibel scale

Pressure (μPa)	Level (dB SPL)	Example
20×10^{11}	220	Cannon @ 4 m
20×10^{7}	140	Jet engine
63×10^{6}	130	Jack hammer
20×10^{6}	120	Discotheque (pain threshold)
63×10^{5}	110	Hammered steel @ 1 m
63×10^{3}	70	Conversation @ 1 m
20×10^{3}	50	Quiet street
63×10^{2}	40	Quiet house
20×10	20	Whispered voice @ 1 m
63	10	Minimum outside
20	0	Reference level

Amplitude envelopes



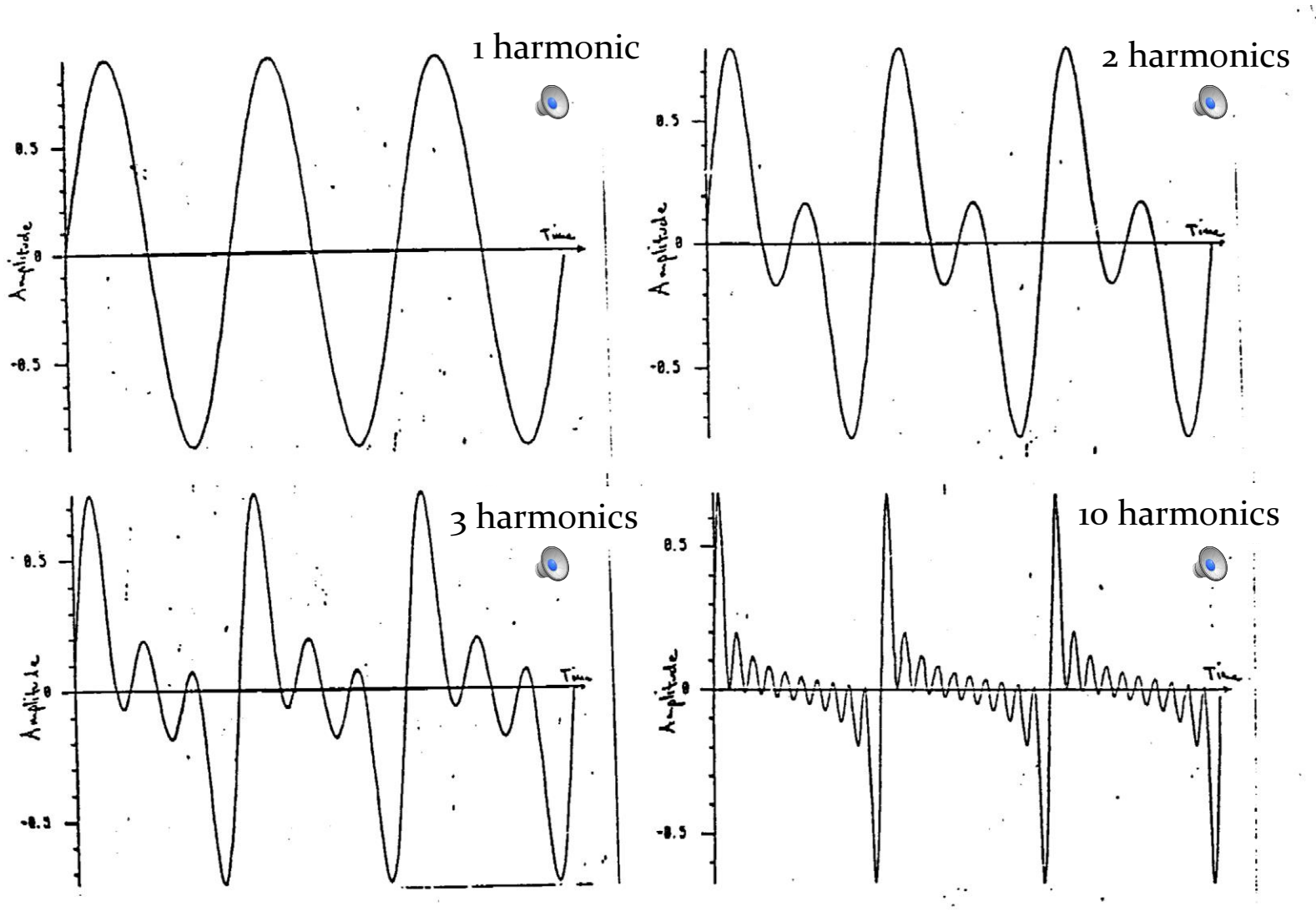
Rectangular

Trapezoidal

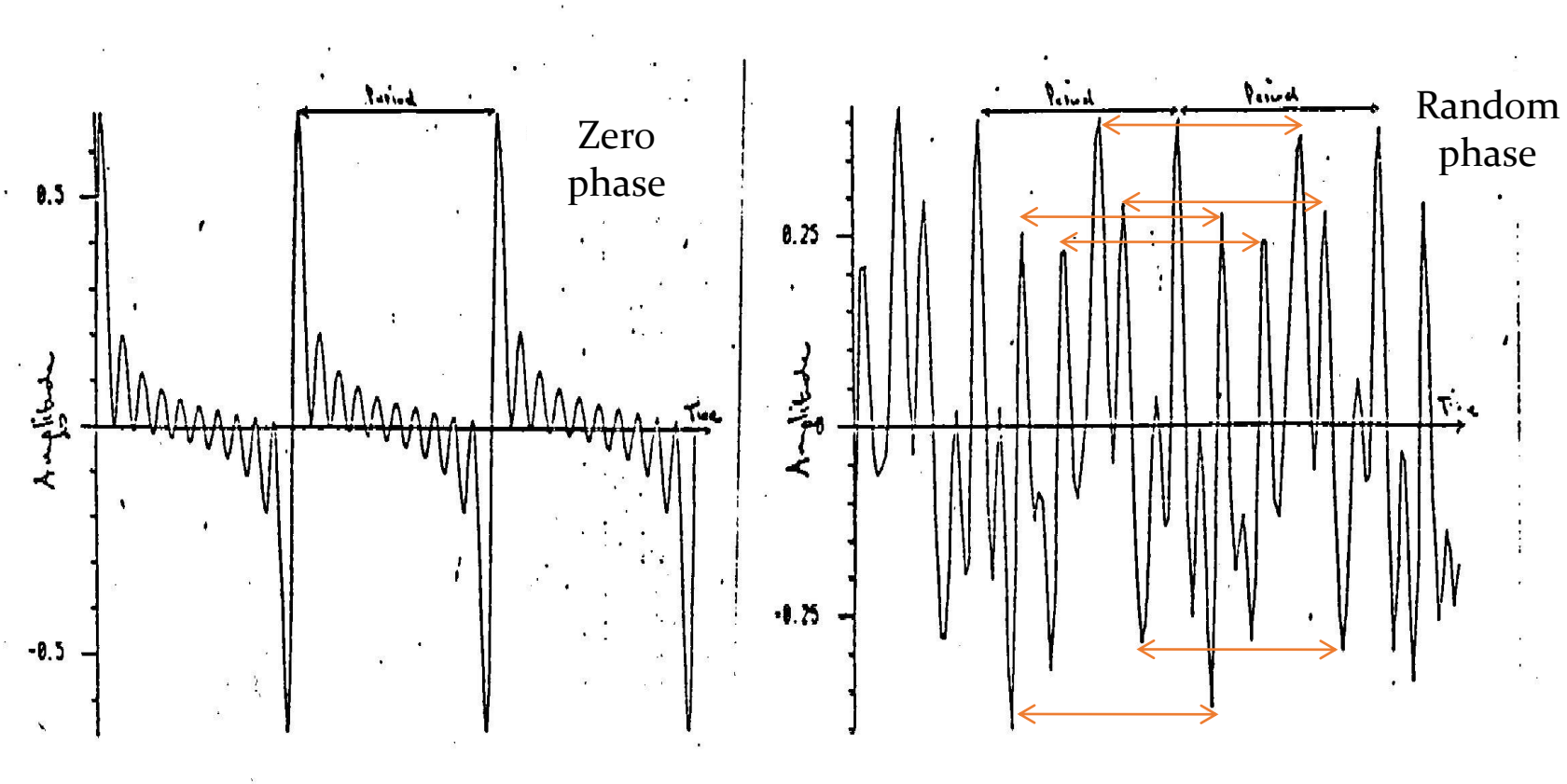
Exponential

Cosinusoidal

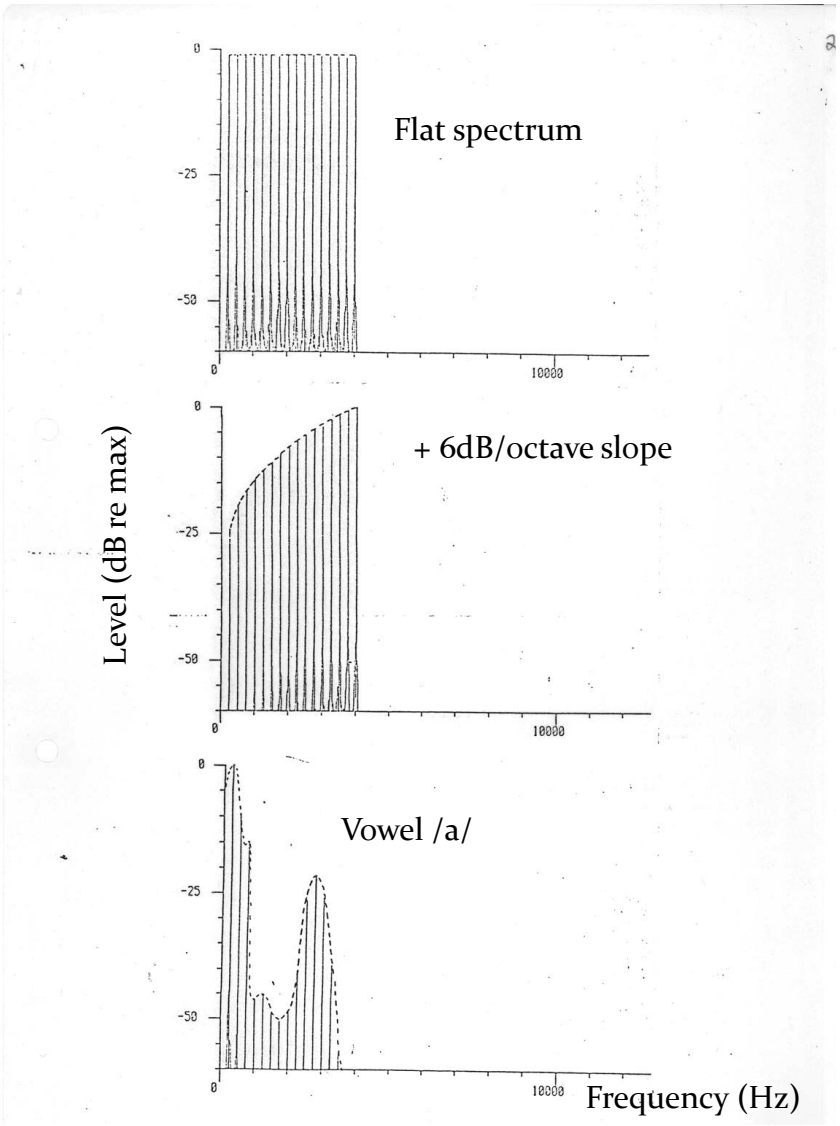
Complex waveforms



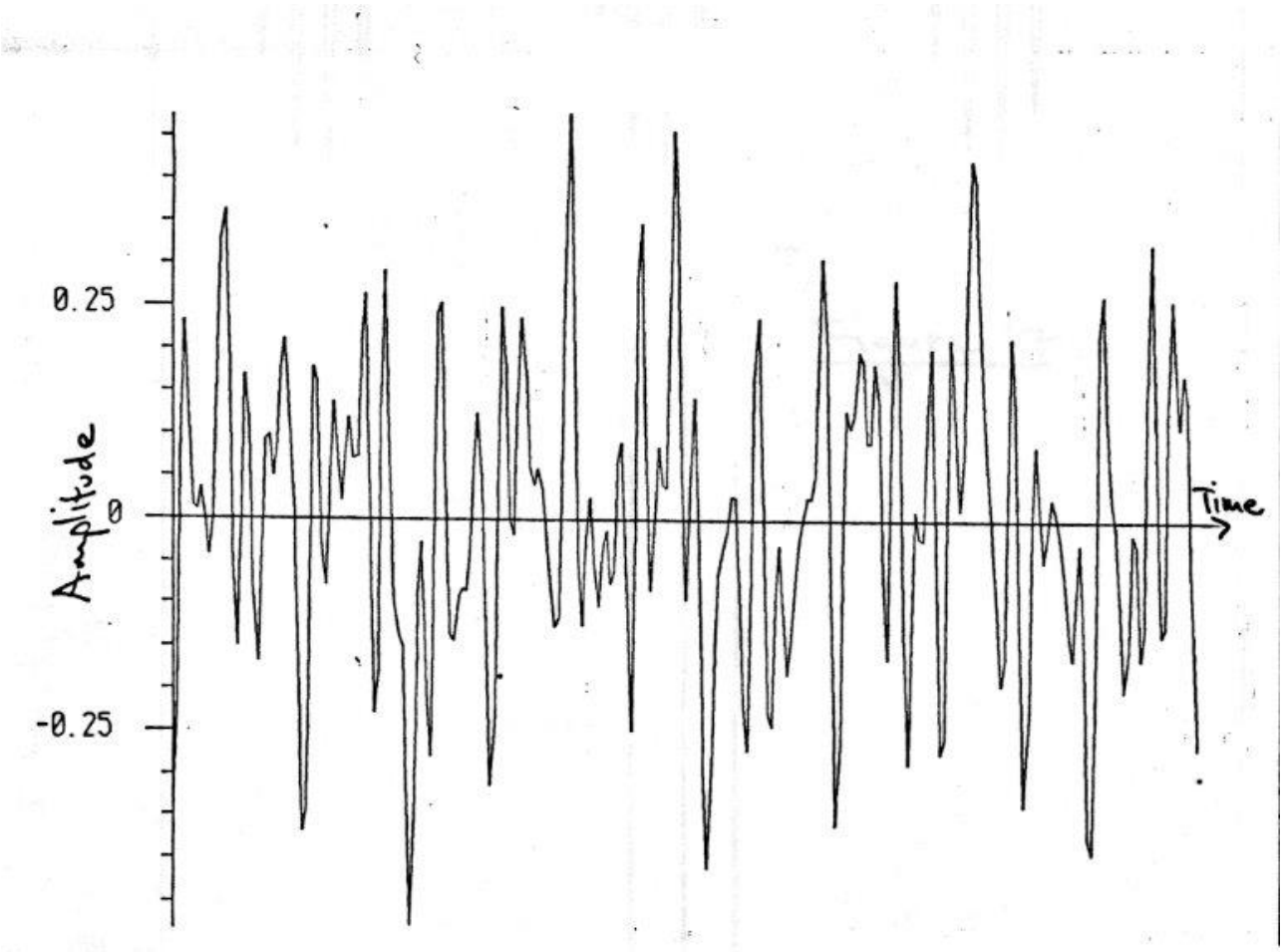
Complex waveforms



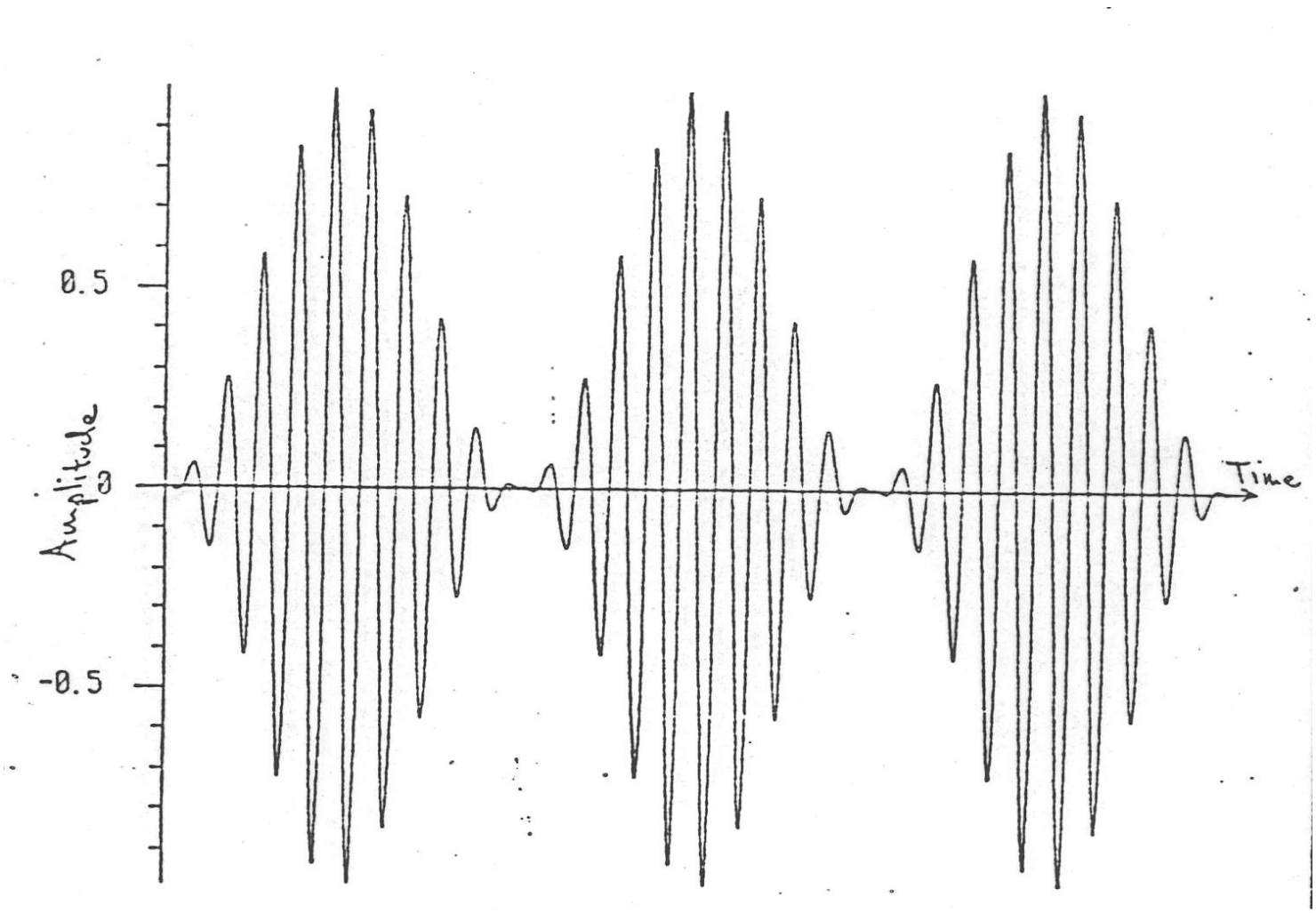
Spectral envelopes



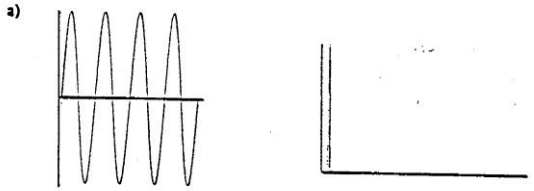
Aperiodic waveforms



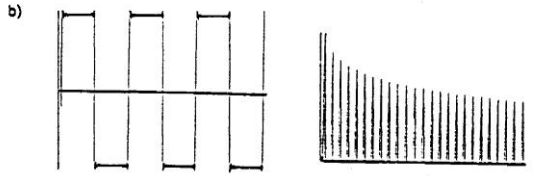
Amplitude modulation



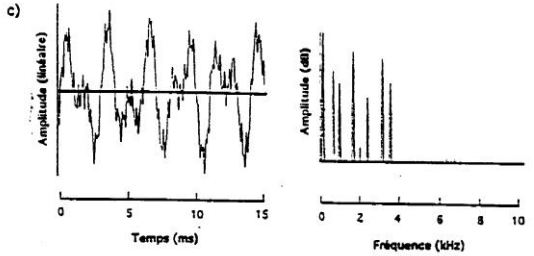
Waveforms and spectra



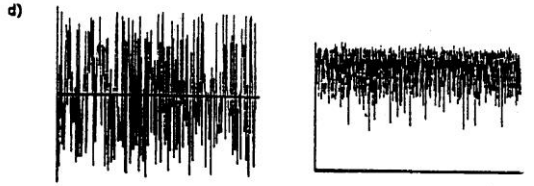
Sine wave



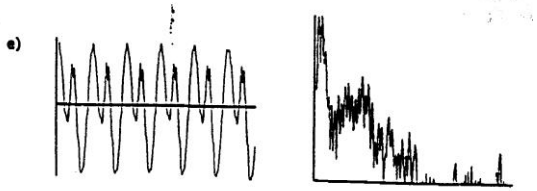
Square wave



Bell sound



White noise



Vowel sound

Time-frequency-amplitude representations